34. (New) The coil according to claim 7, further comprising a reflector attached to an end of the coil.

35. (New) The coil according to claim 18, further comprising a reflector attached to an end of the coil.

36. (New) The coil according to claim 22, further comprising a reflector attached to an end of the coil.

Conclusion

In view of the above amendments and remarks, it is believed that the application is in better form for examination. If a telephone conversation with Applicants' attorney would expedite prosecution of the above-identified application, the Examiner is urged to contact the undersigned at (617) 832-1175.

Respectfully submitted,
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MARKED-UP VERSION OF THE SPECIFICATION

Page 4, line 5

[This method] Using the above relations allows the fabrication of Faraday-effect sensing coils that do not require annealing. However, achieving this effect requires a specific number of turns or twists (determined by the equation for T) in the helix which is wound around the torus mandrel. Blake also notes that introducing a large number of twists in the optical fiber is impractical as such a tightly-wound fiber will creep over time. It would therefore be desirable to develop a less complex fiber-optic sensor coil, i.e., one which depends only on pitch angle and not requiring a specific number of turns or twists, yet having a significant effect comparable to circular birefringence that can overcome or "swamp" any residual linear birefringence of the coil.

Page 4, line 15:

According to one aspect of the invention, a fiber optic sensor coil for a current sensor for increased sensitivity may have at least one winding. The sensing fiber may be wound without torsion, i.e., without torsion twists, around a current-carrying wire to form the coil. A helix can be wound with or without torsion, depending on whether the free end of the fiber in the winding process is constrained from rotation, or permitted to [fully] freely rotate, respectively. The pitch of a torsionless fiber may be selected to result in a specific phase shift of circularly polarized light propagating through the fiber, wherein the phase shift can be caused by Berry's phase.

Page 5, line 7:

Embodiments of the invention may include one or more of the following features. The pitch may be between 20° and 70°, preferably approximately 60°. A pitch outside this range may be used, though may not provide an optimum effect. The form on which the fiber is wound may be slotted such that the fiber helix may be threaded onto the conductor without breaking the conductor. The sensing fiber may be wound in the form of a bobbin, the fiber having a first section with a first winding direction and a second section with a second winding direction. The pitch of the fiber will necessarily decrease to zero so as to reverse the winding direction. The sense of phase rotation, however, may not be changed. The length of fiber in the reversal region may be minimized, as it does not produce a Berry's phase shift. The fiber may also be wound in the form of a helix around a torus, which encircles the conductor.

Page 7, line 12:

Referring now to Fig. 1, in one embodiment of the invention, a Berry's phase coil 10 may be obtained by winding a section of optical fiber 14 in the form of a helix, e.g., by winding the fiber around a cylinder 16 having a radius R. Optical radiation produced, for example, by a laser 12 is polarized by a polarizer 13 and [focused] coupled on the end of the fiber 14. The fiber 14 may be wound around the cylinder 16 without torsion, making one turn within a length p of the cylinder 16. The length p is referred to as the "pitch." Radiation exiting the fiber 14 passes through a polarizer 18, with a detector (not shown) detecting a change in the polarization direction.

Page 9, line 17:

Unlike the fiber coils described in the prior art, the coil of the invention may be wound without torsion. This is easily accomplished by either properly rotating the fiber payout spool (one revolution for each winding of the helix), by enclosing the fiber in a loose Teflon tube before winding, and the like. Since no torsion is introduced into the fiber, the number of turns in a coil may be much greater using Berry's phase without concern for creep or stress induced failures. Thus, the possible effect introduced by the Berry's phase may be greater, due to the increased number of turns possible, than if the coil winding method introduced torsional stress or tension into the fiber. The number of turns may be increased, for example, by reversing the helix direction, i.e., by going back and forth in two directions, as will be described in conjunction with Fig. 4.

Page 10, line 12:

In yet another embodiment illustrated in Fig. 4, a helix may also be wound around a cylinder 30 as a bobbin 32. In this embodiment, the winding direction of fiber 34 (along the axis of symmetry x-x) may be reversed as the fiber 34 nears the end 36 of cylinder 30. The winding may then proceed in a direction towards end 38 of cylinder 30 and may reverse back towards end 36 as the fiber 34 nears end 38. In the illustration of Fig. 4, two reversals are shown, but it will be understood that winding of fiber 34 in this bobbin fashion may have one or more reversals. When reversing direction at the end 36, or end 38, the pitch of the fiber 34 typically decreases to zero at some point. Since a 90° pitch does not produce a Berry's phase, the length of fiber in the reversal regions near ends 36 and 38 should be minimized. Any of these sensing coils may be configured as either a

Sagnac interferometer (although using the Faraday effect to achieve the phase shift) or a reflective coil, by introducing a reflector at the end of the fiber most distant from the optical source. Winding of the helical coil in this bobbin fashion is advantageous where the axial length of the coil is much shorter than <u>would be necessary to accommodate</u> the number of turns. Since the sense of rotation is unchanged, the Faraday effect is still cumulative. If the coil starts and ends at the same point along the length of the conductor, i.e., an odd number of reversals, this establishes a closed integral path, with the sensing coil enclosing the current and minimizing sensitivity to non-uniform magnetic fields. Whether a cumulative Berry's phase exists is not relevant, since it is the Berry's phase per unit length, compared to the linear birefringence per unit length that is the determining performance factor.

<u>Page 11, line 19</u>:

One embodiment of the Berry's phase coil may be employed with fiber-optic current sensors, for example, having the design illustrated in Fig. 5. Light emitted from a suitable light source 42 may pass through a first 3dB coupler 1 where half of the light may be dissipated, and half may be sent through the polarizer 2. A second 3dB coupler 3 may split the light into two approximately equal intensity, counter-propagating beams which may traverse the coil 40, which in the embodiment of Fig. 5, according to the invention, may be a Berry's phase coil. The two light beams exiting the coil 40 may then recombine at the second coupler 3 where they interfere. This combined light beam may then pass through the polarizer 2 a second time in the opposite direction, and half of the light may be directed to the photodetector 44 by the first coupler 1. An optical splitting

ratio of 3 dB is typically selected for the couplers to maximize the optical power incident on the detector. Two λ/4 waveplates 48, 49 may be placed near the sensor coil ends. Those skilled in the art will understand that the λ/4 waveplates are located at the end of polarization-maintaining fiber leads from the coupler 3 which may have a considerable length.